NATION SHALL SPEAK PEACE UNTO NATION

RESEARCH DEPARTMENT

VISIT TO GERMANY TO OBSERVE MEASUREMENTS OF U.H.F. TRANSMISSIONS

Report No. A-073

(1962/43)

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

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SUMMARY

In order to provide preliminary information necessary for the specifications to be used for ultra-high-frequency (u.h.f.) television receivers, the Hohe Eifel area of Germany was visited to observe measurements made by a unit of the Institut für Rundfunktechnik (I.R.T.). The engineers of this team, led by Herr U. Dietz, were extremely co-operative and readily modified their own programme in order to investigate the problem which was of immediate interest to us.

This report describes the results of the investigation, and contains comments concerning the television service in the area. A description of the I.R.T. field strength equipment and their measuring techniques is also included.

1. INTRODUCTION

The intermediate frequency for the vision channel which has been proposed for use in 625-line television receivers in the United Kingdom is 39·5 Mc/s. A disadvantage of this choice is the possibility of image interference, since many of the planned groups of u.h.f. transmitters have a frequency difference of 80 Mc/s (10 channels) between the highest and lowest assignment in each group. If a receiver is tuned to channel "N", and assuming correct tuning, the image frequency will fall 1 Mc/s below the vision carrier frequency of channel "N + 10". In order to arrive at an assessment of the image frequency rejection which will be necessary in u.h.f. receivers, it is important to determine the amount by which input voltages to the receiver can vary due to the differential effects of propagation upon the two frequencies. To carry out such an examination it was necessary to have available u.h.f. transmissions with the required frequency spacing which were radiated from the same mast, and preferably from the same aerial. These requirements were met by the Haardtkopf station in Germany, where Channels 25 and 35 are transmitted, carrying programmes for the Südwestfunk (S.W.F.) and the Bundespost networks respectively. At the beginning of April 1962, an I.R.T. field strength measuring unit was investigating the performance of receiver aerials in the Mosel Valley area, and they readily agreed to carry out the measurements in which we were interested.

During the visit the opportunity was taken to compare current field strength techniques and equipment used by the I.R.T. with our own. It was also possible to obtain an impression of the u.h.f. cover in this region because the measurements were scattered over a wide area. It is apparent that the Mosel Valley is particularly

troublesome because of the precipitous sides and the fact that towns and villages are located on the banks of the river on the floor of the valley. Service is much better in the uplands of the Hohe Eifel, although here, too, several towns are screened from the transmitter. Plans exist for the installation of a large number of low-power relay stations to provide a service to the difficult areas.

2. INPUT VOLTAGE/FREQUENCY COMPARISONS - RESULTS

2.1 Transmitter Details

The Haardtkopf station is located on a hill 660 m above mean sea level (a.m.s.l.) about 30 km east-north-east of Trier. The position of the site and the approximate limits of the nominal service area are shown in Fig. 1. There appear to be several different ways of approaching the site, and since none of the tracks is surfaced this opportunity of choice is a desirable attribute in adverse weather.

The site was originally occupied by a Band II station, which was unattended, but when the u.h.f. services were started a new building was erected and permanent staff employed. The station is obviously still in a state of construction, and it is understood that it is regarded as a "guinea pig" transmitter, because much operational development is carried out there. Two u.h.f. channels are currently radiated, Channel 25 for the S.W.F. and Channel 35 for the Bundespost. Carrier frequencies of these channels are:-

Channel 25: Vision = 503·25 Mc/s Sound = 508·75 Mc/s

Channel 35: Vision = 583·25 Mc/s Sound = 588·75 Mc/s

Most of the transmitting equipment was constructed by Lorenz in co-operation with S.W.F. engineers, and klystron amplifiers are used in the output stages. The type of klystron installed until recently was the Eimac KM 5000-LA using an electro-magnetic field, but recently these have been replaced for operational test purposes by Valvo-klystrons type XK.1000, which have a permanent magnetic field. Four-cavity klystrons are used in the vision transmitter, and three-cavity in the sound. Output power on vision is quoted as 10 kW, although during the tests it was noted that output voltage on Channel 35 was 1 dB below that of Channel 25.

The transmitter outputs are fed through coaxial feeders to a panel aerial system mounted on a cantilever section at the top of a stayed, triangular-section mast, 110 m in height. The aerial, constructed by Lorenz, consists of six tiers each of three panels, four tiers for vision and two for sound. The reason for separate aerials is obscure, but could be attributed to simplification in the design of the combining filter. Maximum effective radiated power (e.r.p.) is 200 kW, radiated over an arc between approximately 225°-045°.

Programme feed for the S.W.F. channel is by direct pick-up from the Koblenz station, and the incoming picture viewed on the Haardtkopf monitor was of excellent quality. The feed for the Bundespost channel was over a 4,000 Mc/s link from Frankfurt, and its quality was inferior to the other programme. The 5 Mc/s bars were not distinguishable, and this lack of resolution continued throughout the tests.

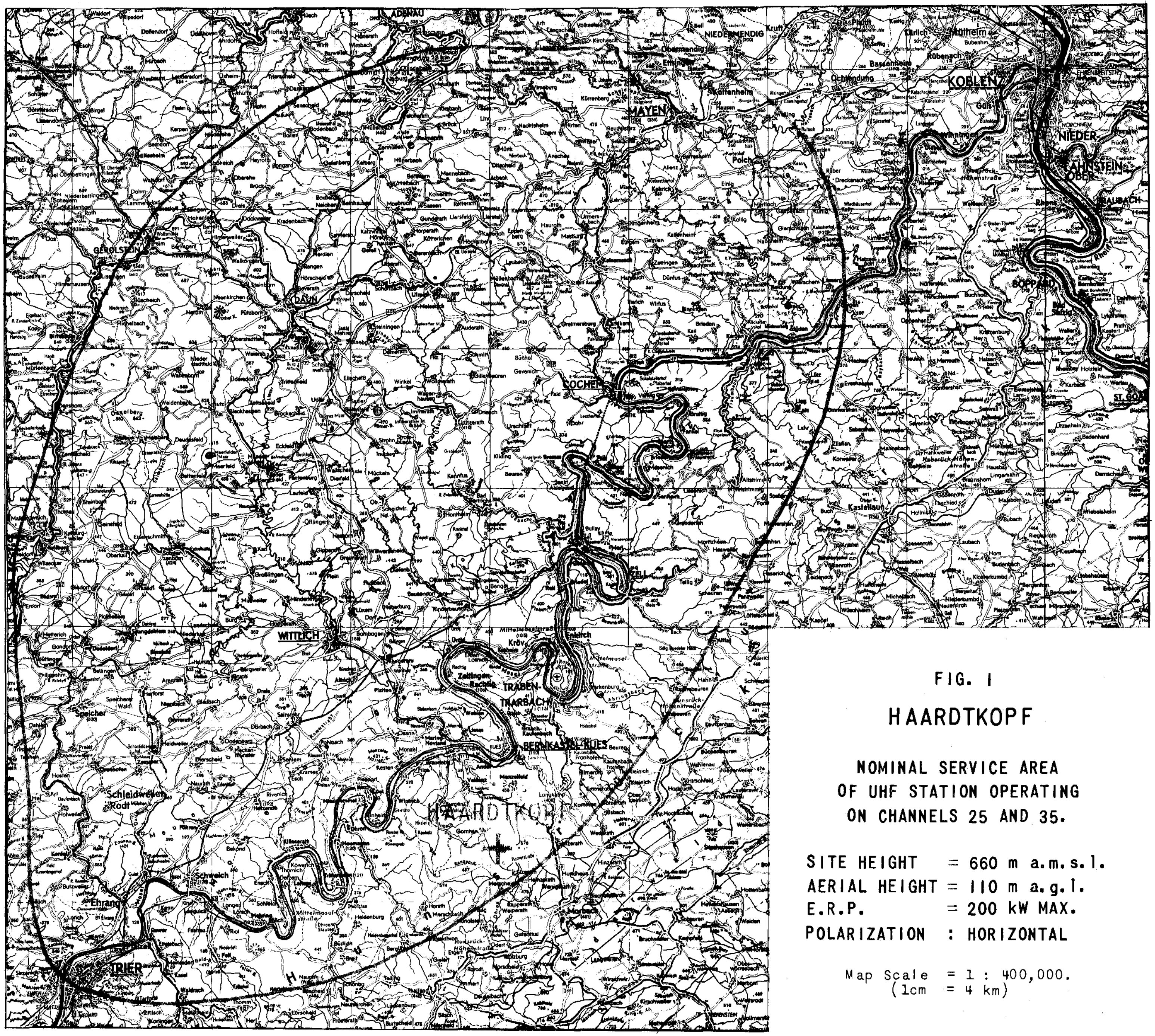


FIG. I

HAARDTKOPF

NOMINAL SERVICE AREA
OF UHF STATION OPERATING
ON CHANNELS 25 AND 35.

SITE HEIGHT	= 660 m a.m.s.l.
AERIAL HEIGHT	= 110 m a.g.l.
E.R.P.	= 200 kW MAX.
POLARIZATION	: HORIZONTAL

Map Scale = 1 : 400,000.
(1cm = 4 km)

The staffing requirements are difficult to assess because the station is still under construction. Current arrangements provide for the constant attendance of at least one engineer, with visits during programme hours of the engineer in charge. The control of the satellite relay transmitters is operated at Haardtkopf, and the increase in their number will require a corresponding expansion of mobile maintenance staff. It was explained that there was difficulty in obtaining personnel for these posts.

2.2 Receiving Equipment Details

Of the three receiving aerials used for the observations, two were commercial products purchased from a radio dealer in Bernkastel-Kues, and the third was a non-directional aerial developed and manufactured by the I.R.T. for field strength measurement. Both commercial aerials were manufactured by Hirschmann, and at the time of the investigation only the maker's data were available. Subsequently the I.R.T. engineers checked the horizontal directivity diagrams of these aerials, and these appear in Fig. 2. Figures relating to the aerials have been supplied by the I.R.T. and are given in Table 1.

TABLE 1

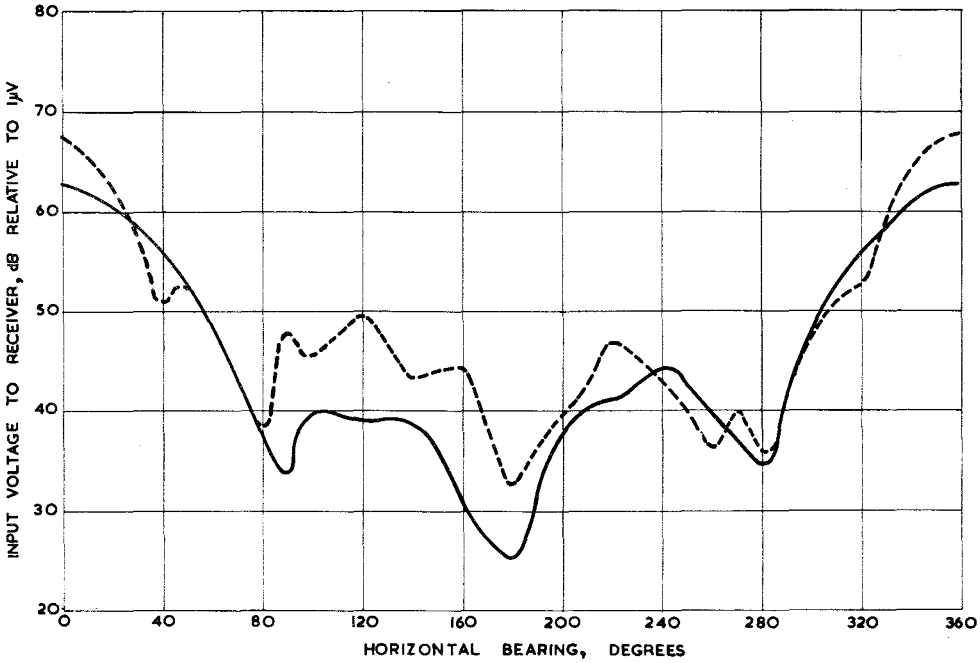
AERIAL	CONSTRUCTION AND COST	FRONT/BACK RATIO (0/180°)		GAIN		E-PLANE HALF-POWER ANGLE	
		Ch. 25 dB	Ch. 35 dB	Ch. 25 dB	Ch. 35 dB	Ch. 25	Ch. 35
Hirschmann 12-element	8 directors, folded dipole, 3 reflectors 46 DM ≃ £4	37	28	4	5	55°	48°
Hirschmann 22-element	Formed by adding boom of 10 directors to first aerial. Boom cost 11 DM ≃ £1	34·5	29	9	10·5	35°	24°

The non-directional aerial developed by the I.R.T. was a single-tier horizontal slot aerial with an omnidirectional horizontal response within ± 2 dB.

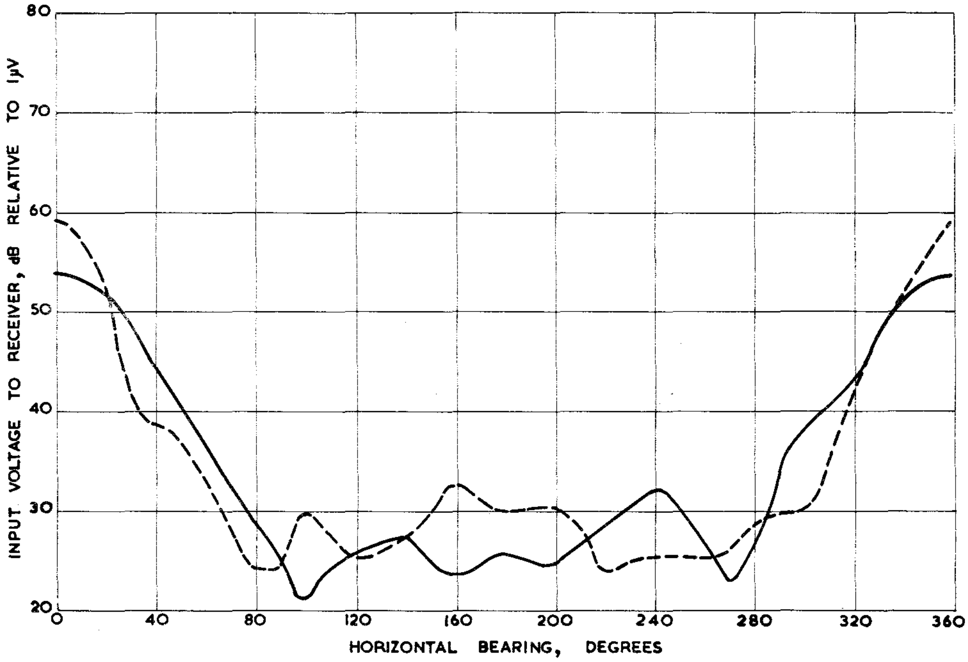
The measurements were made using an R.C.A. field intensity meter in conjunction with a variable attenuator and a Rohde and Schwarz chart recorder. A Blaupunkt television receiver was used to study the picture quality at each site where measurements were made.

2.3 Method of Measurement

It was essential for the investigation that the receiving aerial should remain in the same position for measurements on both frequencies. Thus a direct comparison would be produced showing the extent of the difference for one position of the receiving aerial. Accordingly, each location was selected to be representative



CHANNEL 25



CHANNEL 35

Fig. 2 - Responses in the E-plane of directional receiving aerials used for the measurements

———— 12-element aerial
– – – – 22-element aerial

of a domestic receiving site, the aerial was raised to a height of approximately 10 m above ground level (a.g.l.), and a satisfactory picture was obtained using the vision receiver. The choice of channel on which the aerial alignment was carried out was arbitrary, and depended upon the channel to which the television receiver was tuned; thus if the order of investigation at one site was first Channel 25 and then Channel 35, the reverse order applied at the next site. Once the aerial direction had been established for satisfactory picture on one channel, no attempt was made to improve upon this condition for the second channel until all measurements had been completed. Of course, it would have been possible to have studied the possibility of obtaining a satisfactory picture on both frequencies at all sites by small movements of the vehicle and aerial, but an investigation embracing this problem would have involved much more time.

At all of the sites investigated it was seen that maximum input voltage measured with the receiving aerial directed towards the transmitter corresponded to a picture quality which was regarded as satisfactory. However, at sites where echoes existed it may have been possible to reduce the amplitude of the echo by directing a minimum of the aerial pattern at the source of the echo rather than direct the maximum at the transmitter. Unhappily such a resort might well affect the reception of the other channel adversely, as described later in this report.

As well as measuring the direct signals, the principal echoes at each site were also measured on both channels. The object of this was to compare numerical answers with subjective assessments used by the I.R.T. when describing the visibility of echoes.

2.4 Results

Observations were made using a directional receiving aerial at 84 sites within the nominal service area of the Haardtkopf transmitters, and a further 16 samples were obtained using a non-directional aerial. Generally the directional aerials were elevated to a height of approximately 10 m a.g.l., but this was not practicable with the non-directional aerial, and these measurements were made at 3 m a.g.l. The use of the different aerials gave an indication of the effect which directivity had upon the scatter of differences between the amplitudes of the two emissions. In Fig. 3 the ratios have been plotted in the form of a histogram, and it may be seen that there is an indication that the use of a directional aerial tends to increase the difference. This is attributed to the following reason. The measured field strength will be the vectorial resultant of the direct and reflected signals which exists at the receiving aerial, and if this aerial is directional, some of the vectors are excluded or attenuated. It was demonstrated by the I.R.T. engineers that the directions from which separate reflections originate can vary with frequency, although the total amount of energy received by reflection was not greatly affected by a change of 80 Mc/s (representing an increase of 13·7% over the lower frequency). This relative insensitivity to frequency change may become apparent if a non-directional aerial is used, because the reflected components at u.h.f. often constitute a major proportion of the measured field strength. The effect of changing frequency is seen more clearly if a directional receiving aerial is employed. It is pertinent to note here that some continuous (vehicle cruising) measurements were made with the object of checking part of the horizontal radiation pattern of the trans-

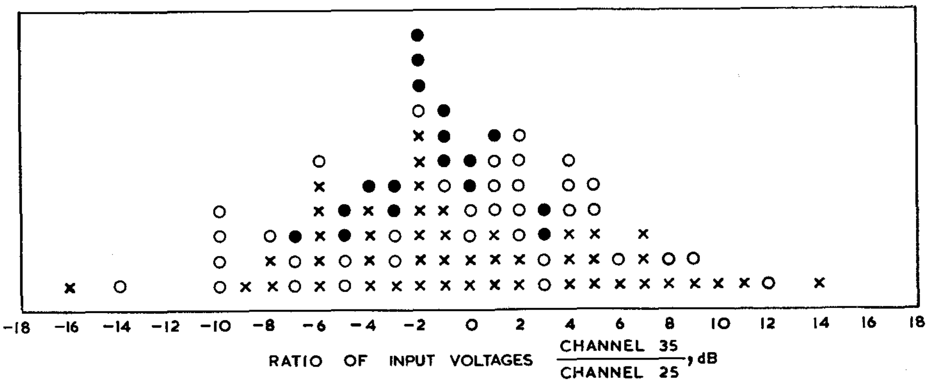


Fig. 3 - Histogram of measured ratios of receiver input voltages to demonstrate effect of receiving aerial directivity

Type of receiving aerial:
× 12-element
O 22-element
● Dipole

mitting aerial, and comparison of the recorder charts showed smaller differences between signal strengths than the values determined with directional aerials.

The fact that the presence of many reflections will decrease the apparent difference when a non-directional aerial is used implies that this result will be most marked when the observation is made in an area which is surrounded by many reflecting surfaces, i.e. at the bottom of the Mosel Valley. Measurements made in completely open country using a non-directional receiving aerial should yield results comparable with the directional aerial, and while there is some evidence that this is so, unfortunately there has been insufficient study. Apart from this, the effect of terrain upon the results obtained using a directional aerial is difficult to assess. Some measurements were made in open country which produced ratios as large as the largest obtained in the bottom of a deep valley. The greatest ratio recorded between the two signals (15 dB) occurred in the immediate vicinity of a building whose roofline was some 10 m above the receiving aerial, and obscuring the transmitter. It would seem that the immediate presence of a diffracting edge can be the cause of a large ratio and the probability is increased if the edge is sharp, such as that due to the presence of a building. Apart from this reservation, there is no evidence in these measurements that the natural features of the terrain play any part in affecting the ratios determined using a directional aerial.

Fig. 4 has been produced from the results and indicates that the distribution of the samples is log-normal. It was mentioned earlier that the output power of Channel 25 exceeded that of Channel 35 by 1 dB, and this correction applied to the results caused the 0 dB ratio point on the curve to correspond to the 50% locations or median value, as it should do.

At three of the sites, where the signal was received by diffraction, there was a difference in receiving aerial direction for the reception of maximum signals on the two frequencies. The I.R.T. engineers had previous experience of this, and attributed it to the nature of the terrain at the diffracting edge which produced

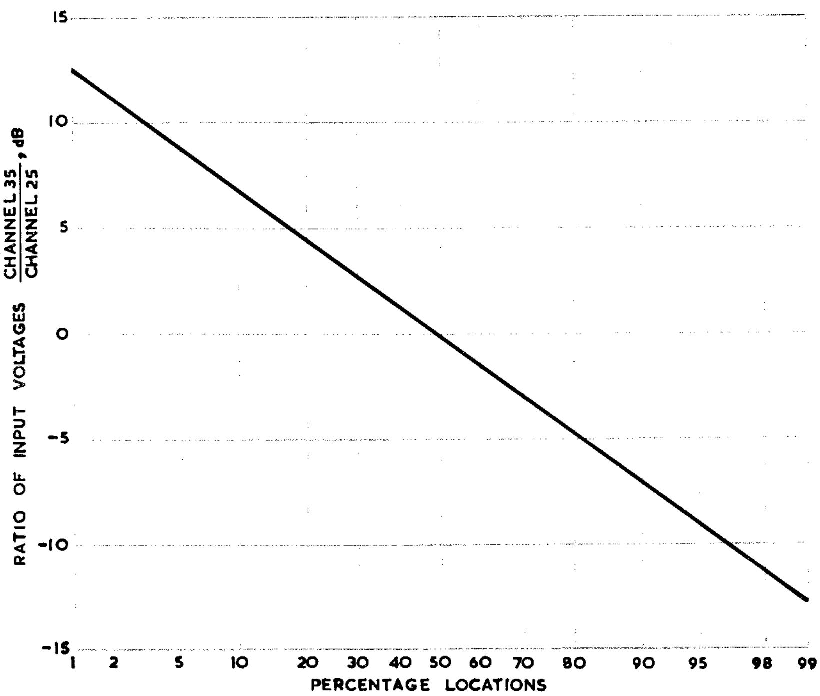


Fig. 4 - Distribution of measured ratios of receiver input voltages. Results corrected so that e.r.p.s are equal

horizontal deflection of the rays. They said the degree of deflection depends upon frequency and they have discovered instances which were more severe than those measured at Haardtkopf. In the worst case it was found that the difference in bearing for maximum reception was 20°, and the loss in field strength of the second channel by measuring on the bearing of the first was 4 dB. The other two cases were much less severe, and it is not thought that this point represents a serious problem.

The quality of the pictures available at each location was studied, and the I.R.T. engineers awarded each a rough subjective assessment. These remarks, together with the measurements made with directional receiving aerials, are contained in the Appendix. When the measurements were made the only information available concerning the performance of the receiving aerial was that supplied by the manufacturer, and results were accordingly quoted in terms of input voltage to the receiver. However, since that time the I.R.T. have produced the necessary data, and results are given in both field strength and input voltages. An analysis of the subjective appraisals is as follows:-

TABLE 2

CLASSIFICATION	PERCENTAGE OF SITES	
	Channel 25	Channel 35
Good or fairly good	48%	36%
Bad or unusable	22%	22%
Unclassified	30%	42%

It is thought that the inferior performance of Channel 35 is partly due to the quality of the transmitted picture.

In addition to the assessments awarded by the I.R.T. engineers, the pictures were also graded in accordance with the system used during u.h.f. tests in the United Kingdom. These grades are as follows:-

1. Excellent
2. Good
3. Fairly good
4. Rather poor
5. Poor
6. Very poor

The result of plotting these assessments as a function of field strength is shown in Fig. 5. This graph illustrates the range of field strength which was covered, and may appear anomalous because it will be seen that wide overlaps occur between grading. Thus a picture provided by a field strength of 70 dB appears in grades 1 to 4 inclusive. It is considered that the overlaps are due to two distinct causes. For much of the time test cards were radiated which permitted the presence of multipath interference to be detected easily. This is a condition of propagation which

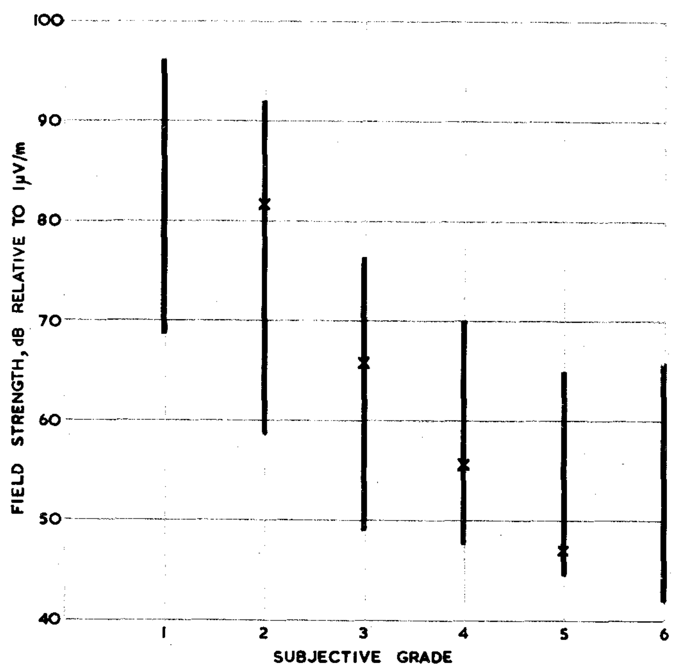


Fig. 5 - Subjective grading of picture quality assessed during Haardtkopf observations. Field strength limits shown for each grade

× Levels of subjective assessments derived from U.K. television field trials (series B - organization MI.)

afflicts the lower values of field strength, and thus accounts for overlaps occurring in grades 3, 4, 5 and 6. The high field strengths which predominate in grades 1 and 2, however, mean that picture assessments are affected less by propagation considerations than they are by transmitted picture quality.[1] Thus the inferior quality of Channel 35 referred to above accounts for much of this overlap.

The levels of subjective assessments derived from United Kingdom television field trials are also shown in the graph. It is believed that the higher range of field strength in the lower grades required in the Haardtkopf observations is again due to the presence of multipath interference, which is more severe than in the Crystal Palace area.

The sites producing good results were mostly in the Hohe Eifel. In the towns and villages along the floor of the Mosel Valley an unsatisfactory picture generally resulted.

3. GENERAL OBSERVATIONS

3.1 U.H.F. Cover of Haardtkopf

Two very distinct types of terrain are embraced by the Haardtkopf service area. There is the undulating country of the Hohe Eifel, which may be likened to the Yorkshire Wolds or the Southern Uplands of the Scottish borders, and there is the Mosel Valley, the serpentine nature of which combined with its steep sides resembles the Wye Valley. The usual affliction of the television planner is apparent in that the majority of the population live in valleys screened from the transmitter, and consequently the area is a difficult one to serve. The Haardtkopf station is situated on the south-eastern edge of the service area, the location being the second choice of the planners. The hill which they had preferred was used as a radar station, and was unavailable.

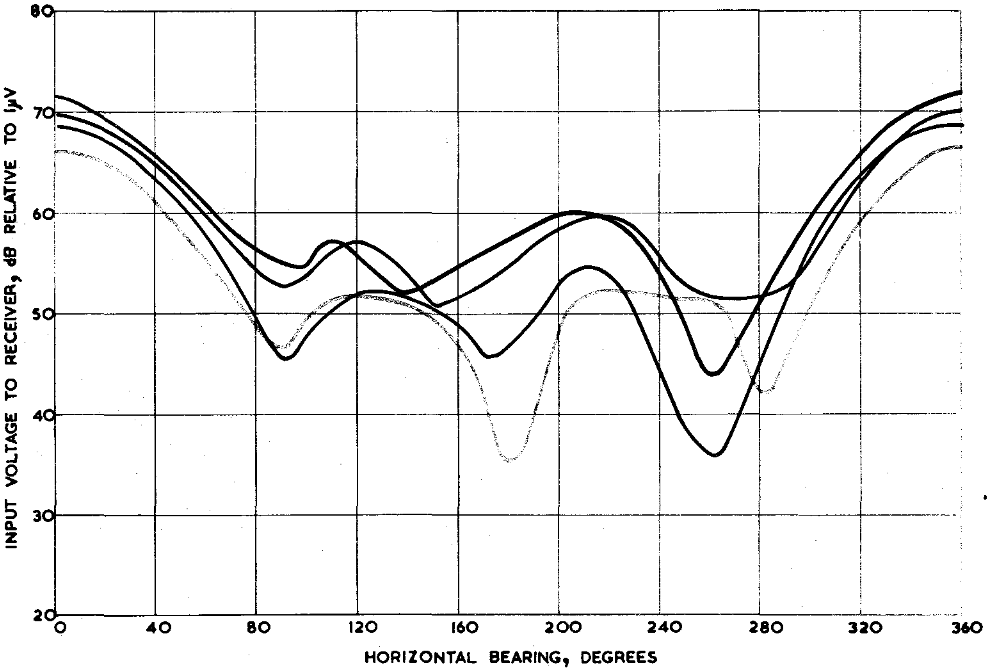
Haardtkopf is, in effect, a high-power parent station, because it is necessary to add a number of relay stations to the system. At the present time there are eight stations within the area operating on Band IV, and 24 in Band III, while plans exist to add a further 24 stations in Band IV. Thus the population which will obtain a direct service from the main transmitter will constitute a small percentage of the total. From past experience of the high field strength values of u.h.f. signals which are available at good sites (the type of situation where a relay station would be sited to re-radiate the programme into a valley) it seems questionable whether it would not have been better to use a low-power unattended parent station and thereby reduce running costs. However, Herr Dietz said that this high e.r.p. was necessary in order to provide an adequate service to viewers living in intervening country not covered by a relay transmitter. Provided multipath interference is not perceptible, people living in zones where the signal is received after experiencing a single diffraction can often receive an adequate field strength.

The principal trouble which afflicts the service is certainly multipath interference. It was noticeable that in the Hohe Eifel far fewer echoes are apparent, even in towns screened from the transmitter. In this region the sources of echoes are probably buildings rather than terrain, but in the Mosel Valley the reverse is

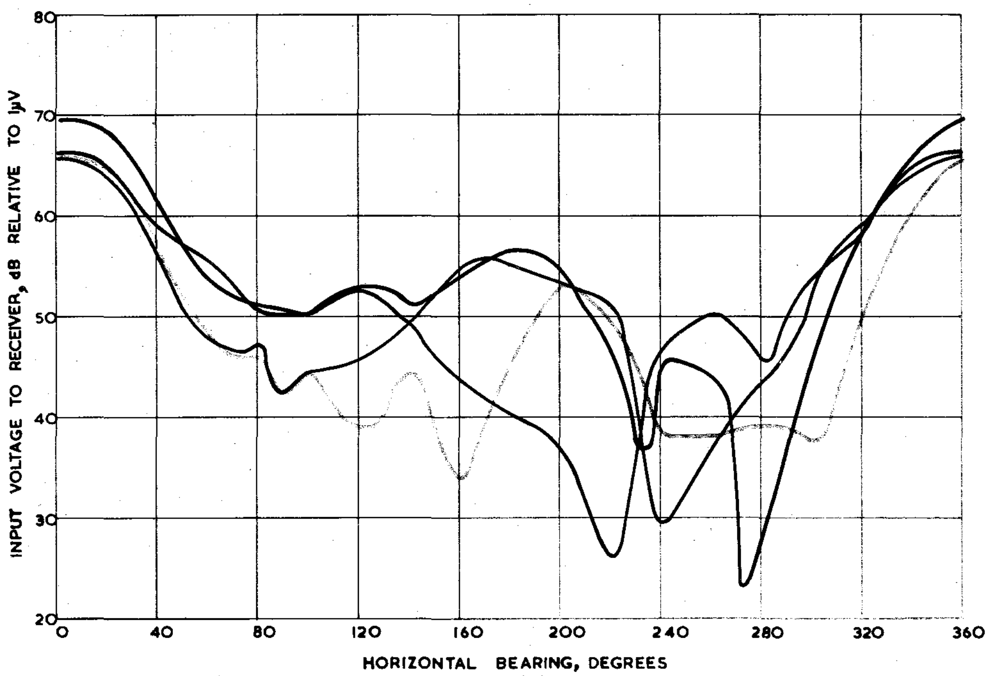
true. Observing the sinuous nature of the valley it is possible to study the effect of the precipitous sides in producing echoes. Where the valley runs at right-angles to the direction of propagation, and the observations are made on the side of the valley nearer to the transmitter, the opposite side is illuminated and the site is rich in echoes. Furthermore the direct signal will be relatively weak, so that the ratio of direct to indirect signals will be small. Where the valley runs in the direction of propagation, echoes are less prominent, unless the direct signal is again severely obstructed. The I.R.T. have found that provided the field strength of the echo does not exceed that of the direct signal by an amount greater than +3 dB, it is possible to obtain a satisfactory picture using a directional aerial. Of course, this condition may be difficult to meet if there is more than one echo of this amplitude.

Another interesting point revealed by the I.R.T. concerned the effect of the nature of the reflecting surface upon the strength and visibility of the reflection. Overgrown slopes, they point out, produce echoes which will vary in phase and amplitude due to wind motion. The degradation of the picture in these circumstances is not so serious as the situation which arises when the echo is produced by a motionless surface. The slopes of the Mosel Valley are covered with vineyards and during the summer these are in leaf. However, in early April, when this investigation took place, the slopes were bare, and it may be assumed that, in the light of the I.R.T. experience, pictures were then seen at their worst. It would, of course, be inadvisable to classify a service as satisfactory if reception is good during summer months only.

A further point connected with multipath interference is currently being studied by the I.R.T. This concerns the response of the receiving aerial to echoes produced at different frequencies; they have shown that with co-sited transmissions, multipath patterns are different on each channel. Although the total amount of energy reflected from all directions remains substantially the same, the directions from which the echoes originate vary widely. This is illustrated by Fig. 6 which shows the echo patterns of Channels 25 and 35 for receiving aerial heights of 7, 8, 9 and 9·6 m a.g.l. This means that in shadowed areas optimum aerial positioning for one channel may not coincide with that for the second channel, which may be troubled by echoes. Practical experience of this was related by a dealer in Bernkastel-Kues who said that in only 25% of domestic installations in shadowed areas was he able to obtain satisfactory reception of both channels with one position of the receiving aerial. This may well be the reason for the reluctance in some cases to change from v.h.f. service to u.h.f. It was not practicable to assess the quality of Band I pictures to compare them with Band IV, but it was apparent that several viewers in the Mosel Valley continue to use the Band I service provided by Goettelbornerhoehe. The experience of the I.R.T. is that the compact nature of u.h.f. receiving aerials simplifies the reduction of echoes when compared with Band I, but it is not possible to indicate, in this case, if more echoes are apparent on Band IV. It is possible, that a combination of doubtful improvement and expensive installation has compelled some viewers to persist with their present Band I service. It is pertinent to note here that when the I.R.T. carried out some colour transmission tests from Haardtkopf, using one channel only, they found that slight maladjustment of the receiving aerial could affect the colour burst. The I.R.T. are continuing a comprehensive series of studies on the directivity diagrams of receiving aerials and they have kindly agreed to let us have further information as this becomes available.



(a)



(b)

Fig. 6 - Responses in the E-plane of directional receiving aerial at a site in the Mosel Valley. Results on the two channels shown for different aerial heights

(a) Channel 25

(b) Channel 35

9·6, 9, 8, 7 Receiving aerial heights, m

The impression gained from observations in the Haardtkopf area is that the installation of the receiving aerial is regarded as an important part of the dealers' service. Two men are usually employed on this task, one with the aerial, and one with the receiver. Sometimes the aerial feeder is used as a telephone line between the men, but in the absence of this, a third man in the street passes the necessary instructions. In this particular area the practice appears to be to try first a simple aerial (up to 12 elements), and if this is unsatisfactory, to progress to a more complex system. In some difficult places very complicated arrays had been installed. The cost of the installation varies between 100 and 200 DM (approximately £10–£20), and the dealers say that this part of the transaction does not yield profit. Certainly the time taken to perform a satisfactory installation, especially in shadowed areas, must produce high labour costs. The degree of precision involved in an actual installation was not seen, but it is understood that the operation is carried out conscientiously. In difficult areas the I.R.T. agree that it is more important to give preference to a good directional aerial rather than to high gain. It has been found that the use of aerials in juxtaposition, which can produce an acute zero point, will reduce a troublesome echo. While the maximum direct field strength can be correlated with satisfactory picture, a single echo can be eliminated in this way by re-orientation of the aerial. Unfortunately, when two channels are radiated from a common aerial, this improvement may not work for both frequencies, because, as described before, the multipath patterns can be substantially different on the two channels.

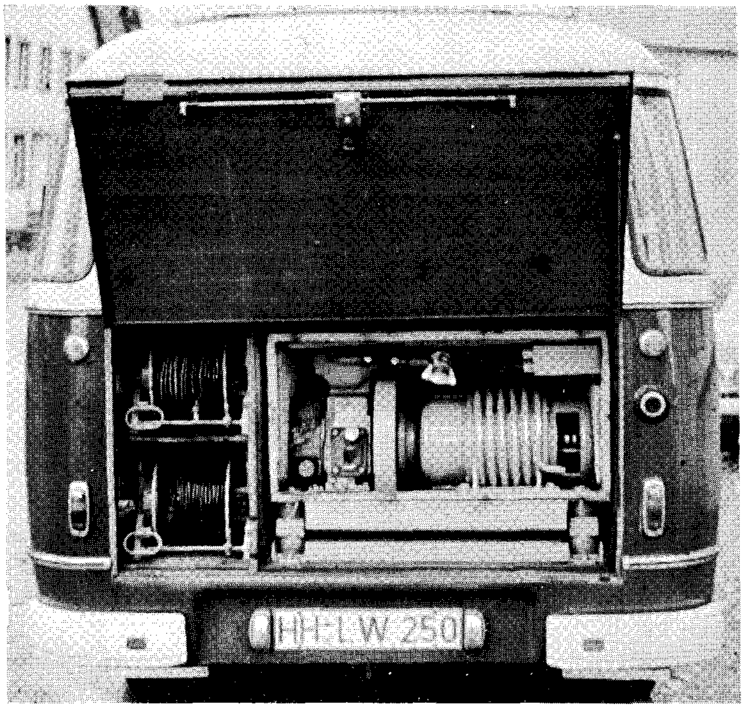
3.2 Methods of U.H.F. Measurement and Equipment used by the I.R.T.

The survey measurements of broadcast services in Germany are performed by field strength units equipped by the I.R.T., the broadcasting companies and the Bundespost. The principal method employed by the I.R.T. for determination of u.h.f. survey areas involves continuous road measurements carried out by a moving vehicle equipped with a non-directional receiving aerial mounted approximately 3 m a.g.l. These measurements are supplemented by spot measurements with the aerial at 10 m a.g.l. in the towns.

The vehicle used for the Haardtkopf measurements is one of a pair owned by the I.R.T. It is a Mercedes 319, designed and built in 1957, and of roughly the same external dimensions as the Commer 1500 used by the B.B.C. Field Strength Section. A general view of the Mercedes appears in Fig. 7(a). Power for the equipment is provided by a built-in diesel generator rated at 2 kW. The generator is water cooled, the radiator being mounted on the roof at the rear of the vehicle. Fig. 7(b) is a photograph of the installation. The sound proofing of the generator was excellent, although the gas proofing was of a lower standard because diesel fumes did occasionally find their way into the interior of the vehicle. Running temperature of the generator coolant varied between 60°C and 85°C with outside temperatures about 10°C. Two air vents for the compartment are provided in its floor, and these are fitted with filters.

The telescopic mast mounted in the vehicle was made by Focke Wulf, and is operated hydraulically. This method was chosen in preference to a pneumatic system, because on occasions it had been necessary for the receiving aerial to remain in the same position for many hours, and air-operated types are prone to slow leaks. The system contains 60 litres of oil and is operated by a pump which, while noisy, seemed

(a)



(b)

Fig. 7

(a) I.R.T. field strength vehicle type Mercedes 319

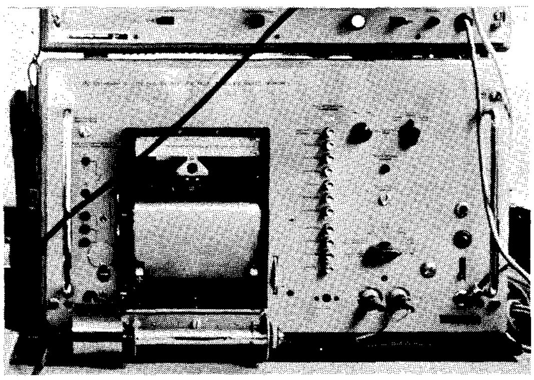
(b) Diesel generator mounted at rear of vehicle

(c) One of the receiving aerials used for for the observations

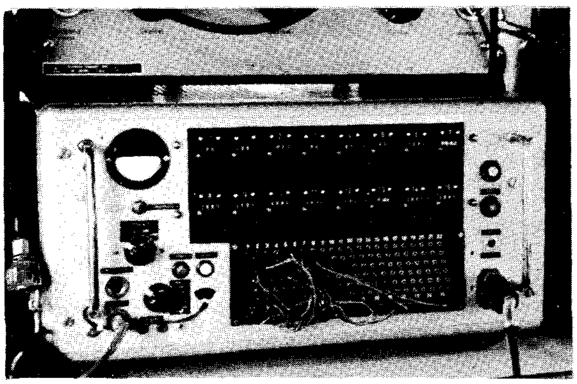
(d) Rohde and Schwarz Enograph G/ZSG chart recorder

(e) Analysing equipment used for counting road sections where field strength exceeds determined values

(c)



(d)



(e)

quite efficient. With a head load of approximately 5 kg, time to raise the mast to its full extension of 9·6 m was 20 seconds. Provision is made for automatically paying out and taking in the aerial feeder, and a perspex panel is fitted in the roof to permit the engineer to see the aerial. Access to the catwalk on the roof to attach the aerials to the mast is via a short ladder between the driver's and the front passenger's seats. Fig. 7(c) shows the driver bolting an aerial to the mast.

The receiver used by the I.R.T. for field strength measurement at u.h.f. is a modified R.C.A. model which they say has been very successful. For paper chart recording a Rohde and Schwarz recorder is installed, this being an Enograph G, type ZSG, and this is shown in Fig. 7(d). The recorder may be driven either by a drive from the vehicle transmission or by internal electric motor, and various chart speeds can be selected by push buttons. The pens used are ball-point refills, which are readily available and do not possess the shortcomings of liquid ink. This type of pen may be used because, unlike the system currently employed by the B.B.C., the writing arm of the recorder is always normal to the surface of the paper chart.

Analysing equipment has been developed by the I.R.T. for use during mobile measurements. This apparatus is illustrated in Fig. 7(e), and consists of a series of counters which register the number of road sections where the field strength exceeds specified values. The lengths of the sections have been fixed at 2 m, and at the end of a 2 km run, the readings of the counters are transferred directly to arithmetic probability paper. This seemed to be an excellent idea, but one shortcoming was the apparent lengthy process of calibration necessary to ensure correct registration by the counters.

The layout of the equipment inside the vehicle is somewhat different from current practice in the B.B.C. The engineer sits in the rear compartment facing forward, with the apparatus mounted in front of him. This means that operation is simple, but if much equipment is required it tends to reduce forward visibility. The equipment is mounted not in racks but on benches, and from the viewpoint of ease of installation, this was admirable. Steel-edged slots run along the length of the benches, and the equipment is strapped in place with H-section fittings similar to ski clips.

General finish of the vehicle was superior to the Commer, and in view of its age, it was well preserved. Herr Dietz attributed this to the attempt to retain the same driver for each vehicle, thereby fostering "pride of ownership". When asked what features he would change if a new vehicle was contemplated, he said the overall conception was still in keeping with their needs.

4. CONCLUSIONS

The measurements detailed in this report give an indication of the variation of field strength with frequency which is apparent at a common receiving aerial. The greatest difference observed between frequencies separated by 80 Mc/s was 15 dB, and there was insufficient evidence to identify the effect of terrain, except in the instance of non-directional receiving aerials. There is some indication that the proximity of large buildings, which obstruct the direct signal, increases the ratio of the two signals.

Current research by the I.R.T. is revealing interesting facts concerning u.h.f. propagation, and their offer to share this information with us is most attractive. The Haardtkopf area is particularly difficult to provide with television but it contains places which are typical of locations in the United Kingdom. For this reason it is considered that tests in more difficult terrain than that found in the Crystal Palace area would be most useful.

The development of the u.h.f. services in Germany has been rapid, and inevitably in this situation, information is being acquired which would have been useful at the beginning of the plan. However, there is justifiable confidence in the I.R.T. that the development can proceed to a successful conclusion.

5. ACKNOWLEDGEMENTS

Gratitude is due to the I.R.T., in particular to Herr U. Dietz and his colleagues, for completing the measurements detailed in this report, and for the concise answers which were given to many questions.

The map, Fig. 1, is reproduced by permission of Mairs Geographischer Verlag of Stuttgart.

6. REFERENCE

1. "The U.H.F. Television Survey of 1957/8: Objective Measurements compared with some Subjective Assessments", B.B.C. Research Department Report No. T-072, Serial No. 1960/8, p. 9.

APPENDIX

Details of Measurements made in the Haardtkopf Service Area

1	2		3		4				5		6
LOCATION	RECEIVER INPUT VOLTS dB rel. 1 µV		FIELD STRENGTH dB rel. 1 µV/m		RATIO PRINCIPAL ECHO/DIRECT SIGNAL				PICTURE QUALITY		REMARKS
					Ch. 25		Ch. 35				
	Ch. 25	Ch. 35	Ch. 25	Ch. 35	Ratio	Bearing	Ratio	Bearing	Ch. 25	Ch. 35	
Mulheim	64	60	76	72	− 5	220°	−19	220°	Good	Faint	
Mulheim	69	63	91	75	− 7	230°	−13	230°	Good	Good	
Mulheim	80	74	92	86	−17	205°	−15	205°	Slightly blurred	Good	
Brauneberg	64	58	76	70	− 3	210°	− 7	210°	Several echoes	Several echoes	
Brauneberg	53	45	65	57	+ 3	260°	+ 8	260°	Bad	Very bad	
					− 1	150°					
Brauneberg	45	43	57	55	+10	210°	+ 8	180°	Very noisy	Very noisy	
Filzen	44	48	56	60	+ 8	200°	+ 4	140°	Noisy with echoes	Noisy with echoes	
Filzen	59	57	71	69	− 6	190°	− 1	140°	Good	Bad	
Wintrich	30	44	42	66	+13	270°	+11	165°	Bad	Bad	High houses
					+10	190°					surrounding aerial
Wintrich	50	34	62	46	− 5	170°	+11	200°	Noisy slight echo	Noisy with echoes	
Wintrich	48	44	60	56	+ 3	175°	+11	230°	Strong echo	Very bad	
Niederemel	40	32	52	44	+11	090°	+12	090°	Many strong	Useless	Better picture from
					+ 9	230°	+12	230°	echoes		reflection
Niederemel	50	47	62	59	+ 2	230°	+ 6	230°	Noisy with echoes	Noisy with echoes	
Niederemel	67	71	79	83	−13	220°	−15	130°	Good	Good	Site on hill
Dhron	–	–	–	–	–	–	–	–	Bad	Bad	
Ruwer	32	37	44	49	+15	220°	+17	220°	Entirely noise	Entirely noise	
Trier	58	57	70	69	− 6	130°	− 6	270°	Good	Echo just visible	
					−13	270°					
Trier	54	55	66	67	− 3	190°	− 3	215°	Fairly good	Several echoes	
					− 5	280°				Useful picture	
Trier	57	53	69	65	− 7	230°	− 7	250°	Good	Somewhat noisy	
					− 5	180°					
Trier	61	60	73	72	−10	200°	− 5	240°	Slightly noisy	Several echoes	
Trier	52	50	64	62	+ 1	270°	− 3	275°	Slightly noisy	Slightly noisy	
					− 3	185°	− 5	185°		Several echoes	
Trier	63	62	75	74	−10	270°	− 6	250°	Slightly noisy	Slightly noisy	

1	2		3		4				5		6
LOCATION	RECEIVER INPUT VOLTS dB rel. 1 μV		FIELD STRENGTH dB rel. 1 μV/m		RATIO PRINCIPAL ECHO/DIRECT SIGNAL Ch. 25		Ch. 35		PICTURE QUALITY		REMARKS
	Ch. 25	Ch. 35	Ch. 25	Ch. 35	Ratio	Bearing	Ratio	Bearing	Ch. 25	Ch. 35	
Wittlich	47	48	59	60	– 5	060°	+ 2	120°			
					+ 4	150°	+ 3	185°	Good	Slightly noisy	High houses
					+ 4	295°					surrounding aerial
Wittlich	66	64	78	76	– 8	160°	– 4	165°	Good	Good	
Wittlich	69	65	81	77	–13	210°	–14	175°	Good	Good	
Trier	59	63	71	75	– 8	220°	–12	180°	Good	Good	
Trier	56	61	68	73	– 8	190°			Good	Good	
					–12	270°					
Salmrohr	42	42	54	54	+ 6	170°	+ 5	120°	Very noisy	Very noisy	
							+11	195°			
Salmrohr	51	53	63	65	– 6	080°	– 2	180°	Good	Echo just visible	
					– 6	170°					
Dorbach	57	55	69	67	–13	110°	– 9	180°	Good	Usable	
					– 6	180°					
Hetzerath	55	53	67	65	– 5	215°	– 5	150°	Good	Fairly good	
Hetzerath	40	42	52	54	+12	195°	0	105°	Bad	Bad	Echoes from all
					0	260°	+ 6	205°			sides
Hetzerath	64	58	76	70	–	–	–	–	Good	Good	High site
Bekond	79	80	91	92	–13	115°	–13	125°	Good	Good	
Bekond	60	68	72	80	–12	230°	–11	230°	Good	Good	
Schweich	55	53	67	65	–11	125°	– 9	135°	Good	Slightly noisy	
					– 6	250°	– 9	135°			
Schweich	41	47	53	59	+16	130°	Echoes from all		Very noisy	Very noisy	
					+10	240°	directions				
Schweich	–	–	–	–	–	–	–	–	–	–	No reception
Schweich	–	–	–	–	–	–	–	–	–	–	No reception
Kirsch	39	44	51	56	+ 8	190°	+ 8	220°	Bad	Bad	
					+11	250°			Many echoes		
Kirsch	47	47	59	59	– 5	180°	– 7	110°	Some noise	Some noise	
					+ 1	280°	– 1	230°			
Longuich	53	44	65	56	– 5	240°	+ 9	140°	Good	Bad	
							– 5	240°			
Fastrau	60	59	72	71	–10	220°	–13	255°	Good	Good	
Fell/Niederfell	37	31	49	43	– 6	200°	+ 9	265°	Very noisy	Very noisy	

1	2		3		4				5		6
LOCATION	RECEIVER INPUT VOLTS dB rel. 1 μV		FIELD STRENGTH dB rel. 1 $\mu V/m$		RATIO PRINCIPAL ECHO/DIRECT SIGNAL				PICTURE QUALITY		REMARKS
					Ch. 25		Ch. 35				
	Ch. 25	Ch. 35	Ch. 25	Ch. 35	Ratio	Bearing	Ratio	Bearing	Ch. 25	Ch. 35	
Dhron	–	–	–	–	–	–	–	–	–	–	Even with 22-element Yagi reception not possible
Kautenbach	41	42	47	48	+12	230°	+10	230°	Pictures not usable	Pictures not usable	
Traben-Trarbach	37	37	43	43	Echoes from all directions				Pictures not usable	Pictures not usable	
Enkirch	51	50	57	56	– 3 – 3	170° 250°	– 2 – 6	245° 275°	Pictures not usable	Pictures not usable	Aerial bearings for maximum signals differ by 15° between channels
Enkirch	42	45	48	51	0 – 2 + 3	110° 250° 300°	+ 2 + 6 – 1	130° 210° 250°	Pictures not usable	Pictures not usable	
Starkenburg	73	71	79	77	–	–	–	–	Good	Good	Highest place in locality
Irmenach	85	90	91	96	–	–	–	–	Good	Good	
Wittlich	85	85	91	91	–	–	–	–	Good	Good	
Minderlittgen	74	76	80	82	–	–	–	–	Good	Good	
Minderlittgen	83	87	89	93	–	–	–	–	Good	Good	
Grosslittgen	47	59	53	65	– 7 + 4	105° 180°	– 9	120°	Slightly noisy	Good	
Grosslittgen	55	57	61	63	– 5	165°	– 2	170°	Good	Good	
Grosslittgen	51	52	57	58	–11	180°	0 –12	180° 215°	Good	Noisy	
Grosslittgen	62	64	68	70	–	–	–	–	Good	Good	
Manderscheid	69	72	75	78	–10 –10 – 4	070° 240° 290°	–14	310°	Good	Good	
Manderscheid	79	83	85	89	–	–	–	–	Good	Good	
Manderscheid	60	64	65	70	– 8	130°	–10	100°	Good	Good	

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1	2		3		4				5		6
LOCATION	RECEIVER INPUT VOLTS dB rel. 1 μV		FIELD STRENGTH dB rel. 1 $\mu V/m$		RATIO PRINCIPAL ECHO/DIRECT SIGNAL				PICTURE QUALITY		REMARKS
					Ch. 25		Ch. 35				
	Ch. 25	Ch. 35	Ch. 25	Ch. 35	Ratio	Bearing	Ratio	Bearing	Ch. 25	Ch. 35	
Manderscheid	47	37	53	43	− 7	070°	+ 9	225°	Noisy	Very noisy	Aerial bearings for maximum signals differ by 20° between channels
					− 4	120°	Many other echoes				
					− 4	120°					
Daun	43	37	49	43	−12	040°	−	−	Noisy	Noisy	
					−12	225°					
Daun	46	38	52	44	−	−	− 4	075°	Noisy	Noisy	
Daun	47	40	53	46	−13	280°	−12	140°	Slightly noisy	Noisy	
					−15	140°					
Daun	45	38	51	44	−13	240°	−12	190°	Slightly noisy	Noisy	
					−13	240°	−12	260°			
Daun	41	51	47	57	− 9	180°	−	−	Noise apparent	Very slight noise	High site
Daun	49	39	55	45	−14	140°	−11	030°	Slightly noisy	Noisy	High site
							− 4	130°			
Daun	55	57	61	63	−	−	−	−	Good	Good	High site
Daun	57	52	63	58	−	−	−	−			High site
Daun	43	44	49	50	−10	320°	−14	180°	Noise apparent	Noise apparent	
					− 9	155°					
Daun					Impossible to determine values						Direct signal screened by hill
Darscheid	76	73	82	79	−	−	−	−	Good	Good	
Darscheid	73	75	79	81	−	−	−	−			
Schönbach	42	37	48	43	−12	125°	+11	180°	Noisy and with echoes	Noisy and with echoes	Aerial bearings for maximum signals differ by 10° between channels
					+ 4	200°	Many others				
Ulmen	62	52	68	58	−10	210°	− 1	040°	Good	Good	
							− 6	155°			
							+ 1	215°			
Ulmen	58	55	64	61	− 2	180°	+ 3	200°	Good	Good	
Ulmen	57	55	63	61	− 1	150°	− 3	170°	Good	Good	